

Plan for Accelerator Beam Study Towards J-PARC Muon Project

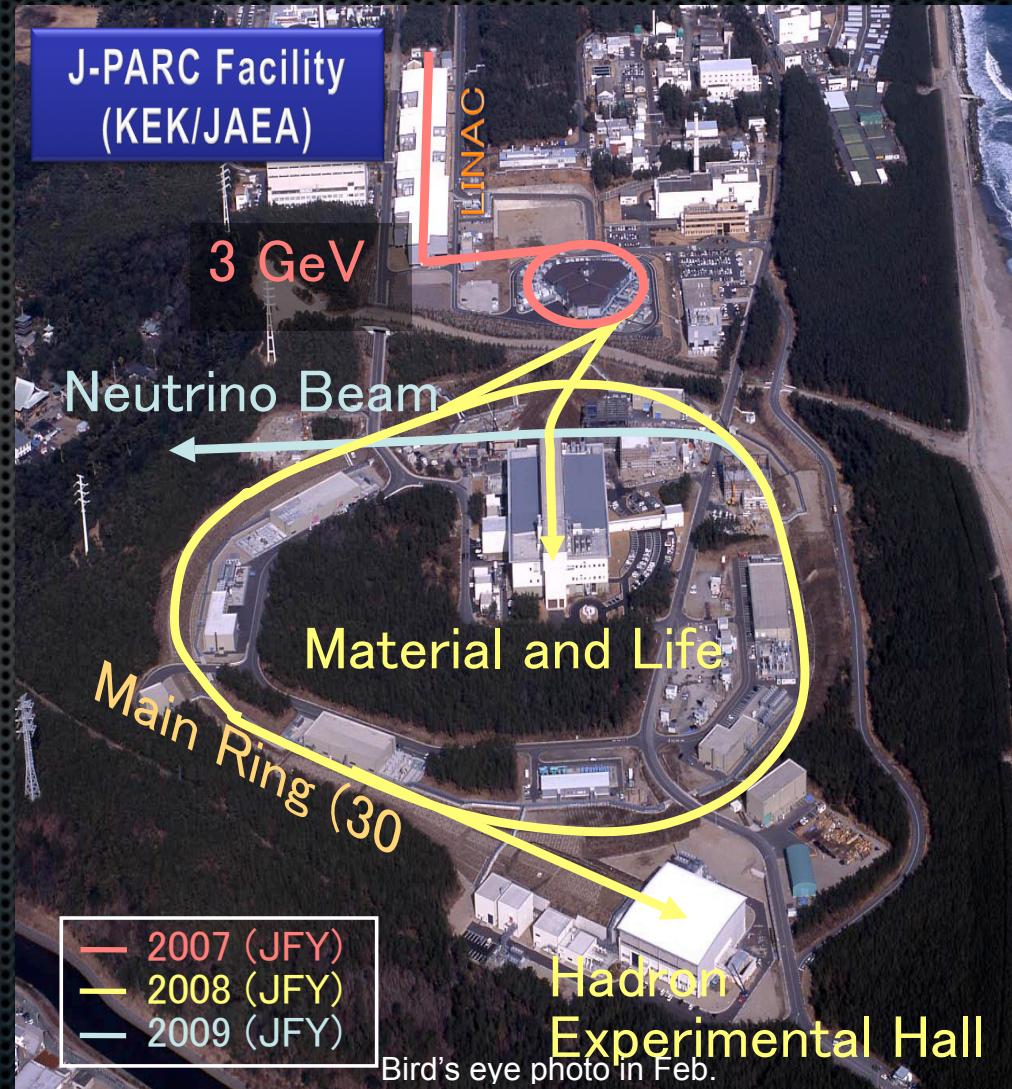
Koji YOSHIMURA (KEK)
for KEK Muon Working Group
at NuFACT08 July 2nd, 2008

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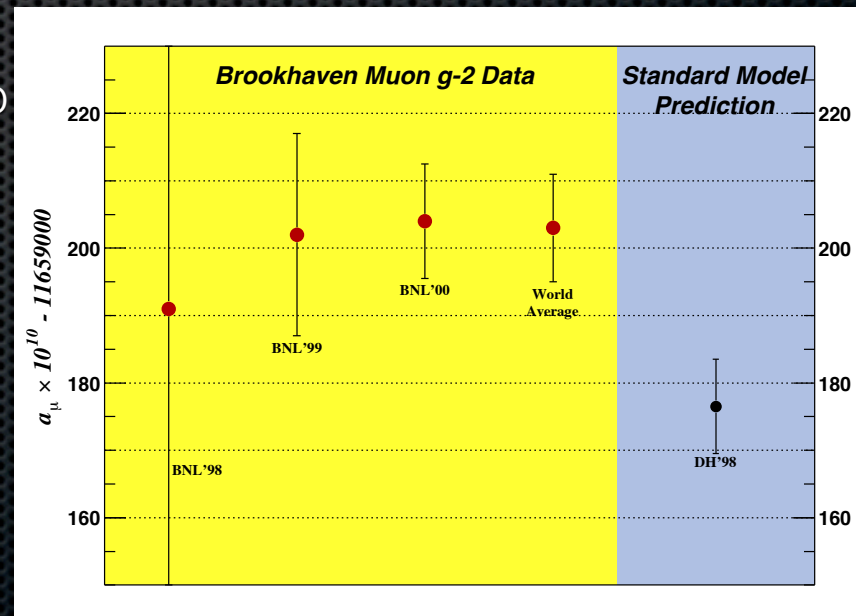
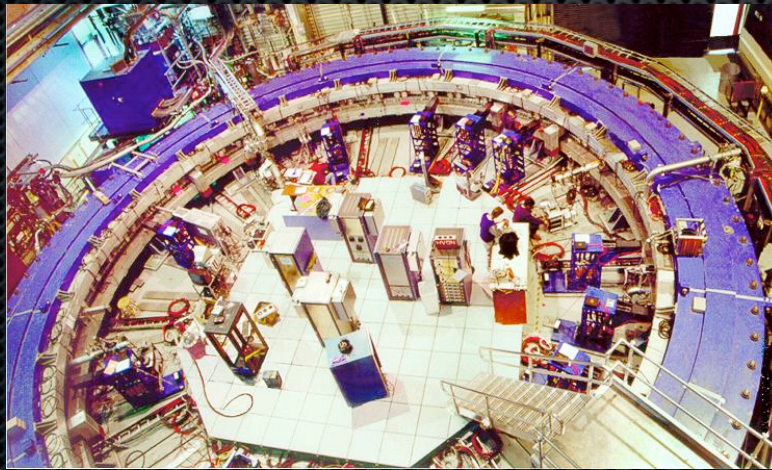
Introduction

- ❖ Muon projects at J-PARC
 - ❖ There are two beam lines for 50 GeV proton synchrotron.
 - ❖ No muon project for particle physics was not built in both beam line.
 - ❖ Now three project is being proposed at J-PARC.
- ❖ Muon trio
 - ❖ muon g-2
 - ❖ muon EDM
 - ❖ mu-e conversion



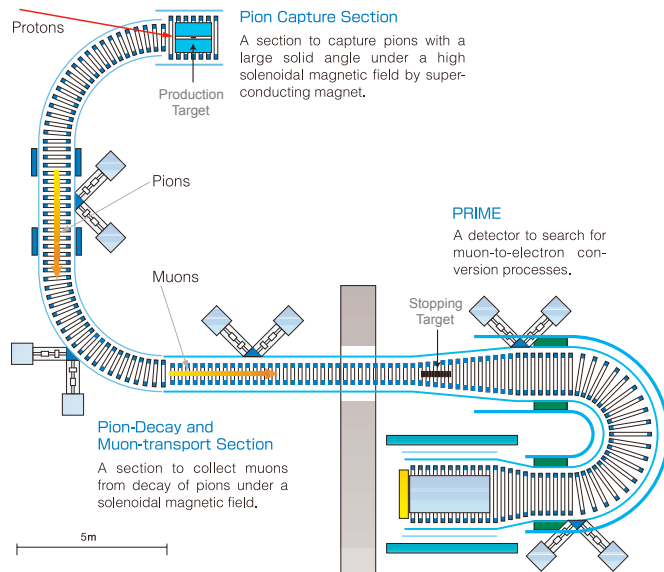
g-2

- ✦ Plan to Improve BNL E821 experiment by factor of 5~10
- ✦ Experimental site may move from BNL to
 - ✦ FNAL, J-PARC
- ✦ Beam requirement
 - ✦ More frequent injection
 - ✦ high repetition rate to reduce pile up



COMET/PRISM

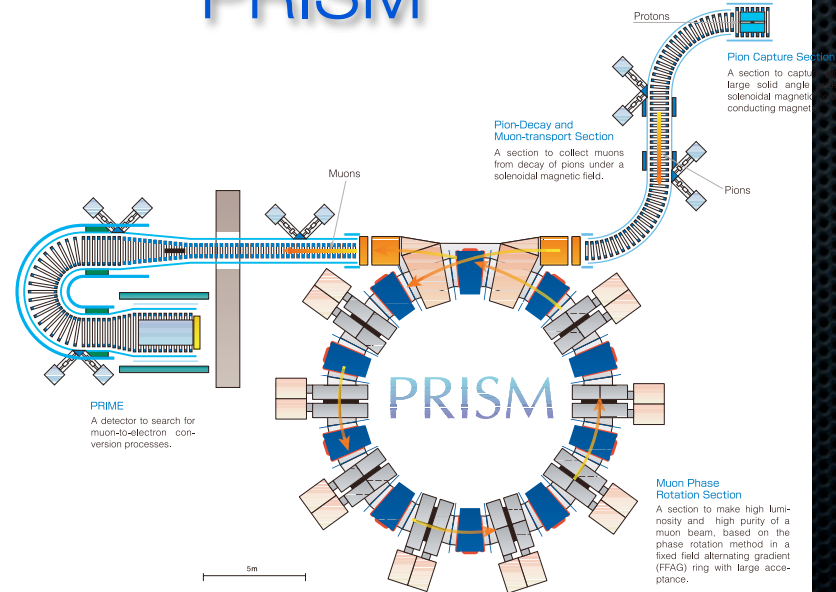
COMET



$$B(\mu^- + Al \rightarrow e^- + Al) < 10^{-16}$$

- No Phase rotator
- With slow-extracted pulsed beam
- J-PARC NP hall
- First phase
- Early realization

PRISM



$$B(\mu^- + Al \rightarrow e^- + Al) < 10^{-18}$$

- Phase rotator
- With fast-extracted pulsed beam
- New beam line and hall
- 2nd phase
- Ultimate search

LOI, Proposal, CDR ...

- Letter of Intent

- Three LOIs were submitted
- g-2: L17, edm:L22

- Proposal

- COMET group has submitted
- It was already reviewed
- g-2 group are preparing

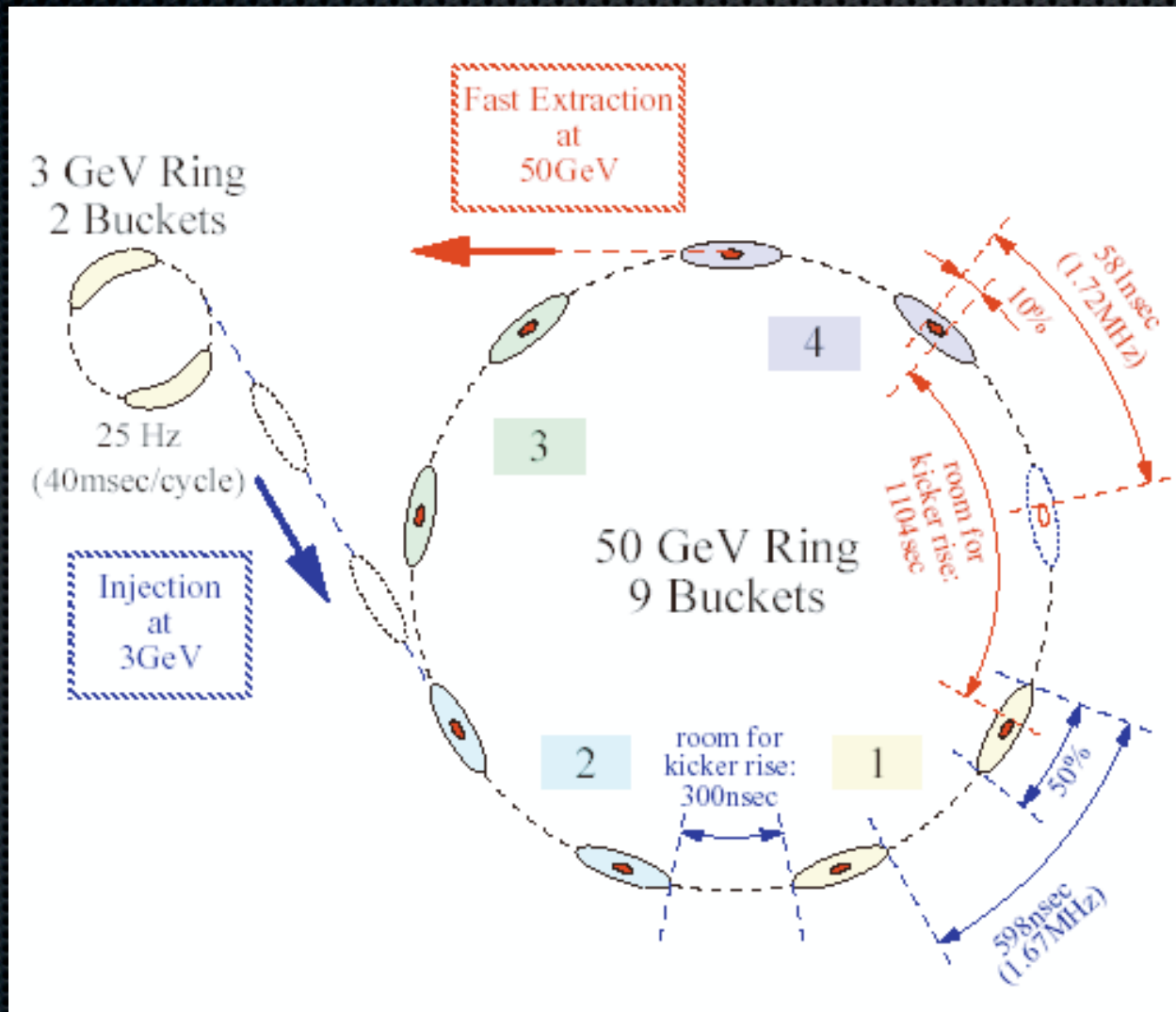
- Conceptual design report

- is prepared in next year.

Q10 from J-PARC PAC

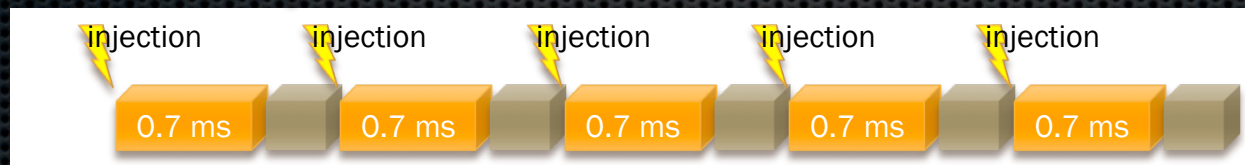
- The beam requirements for COMET running are non-standard. The collaboration need to work with the Laboratory to assess the feasibility and impact of running the J-PARC facility for the COMET experiment.

J-PARC standard bunch structure

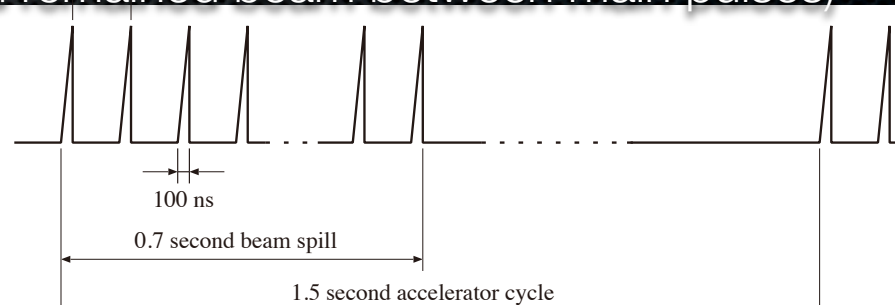


Requirement for beam

- for g-2/PRISM
 - fast extracted beam with 50~90 bunch
 - extracted every 1ms



- for comet
 - slow extracted beam with $E \sim 8$ GeV
 - bunch spacing ~ 1.1 us \Rightarrow 4 out of 9 buckets are filled.
 - Extinction (unwanted remained beam between main pulses)
 - $< 10^{-9}$



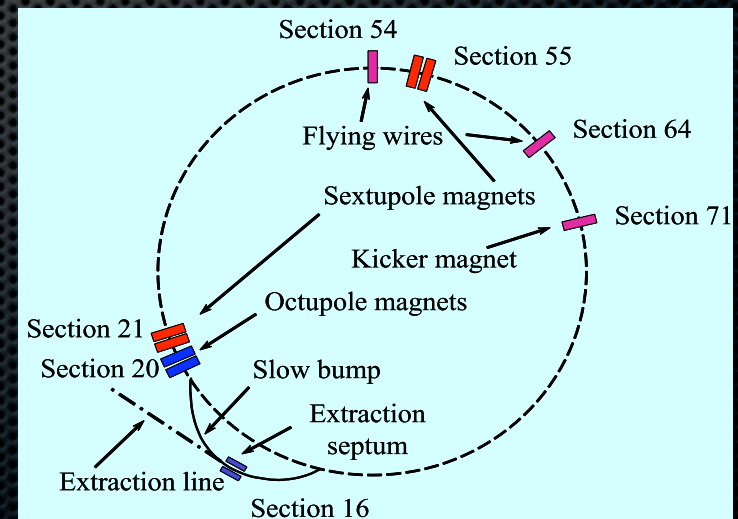
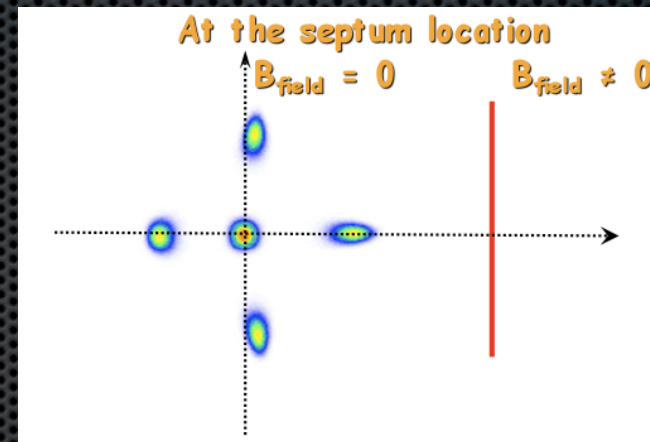
How to increase # of bunches for g-2/PRISM

- Longitudinal only
 - Harmonics number $h=9 \rightarrow h=50\sim 90$
 - debunch \rightarrow capture \rightarrow rebunch
 - fast kicker necessary to kick
- Longitudinal & Transverse
 - Harmonics number $h=9 \rightarrow h=18$
 - Split beam into beamlet transversely by using resonance crossing & nonlinear optics
 - Total $16 \times 5 = 80$ bunch

CERN Study

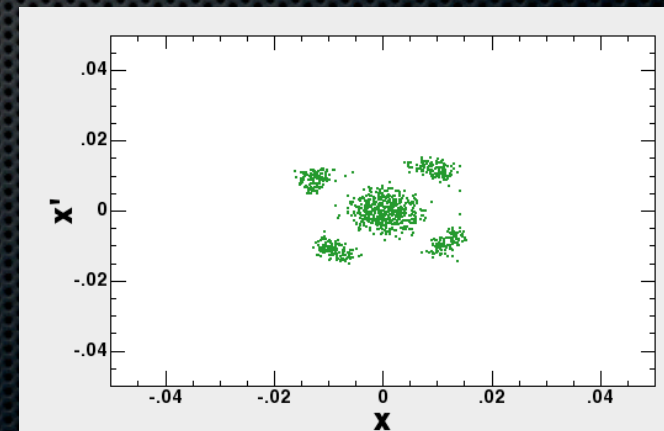
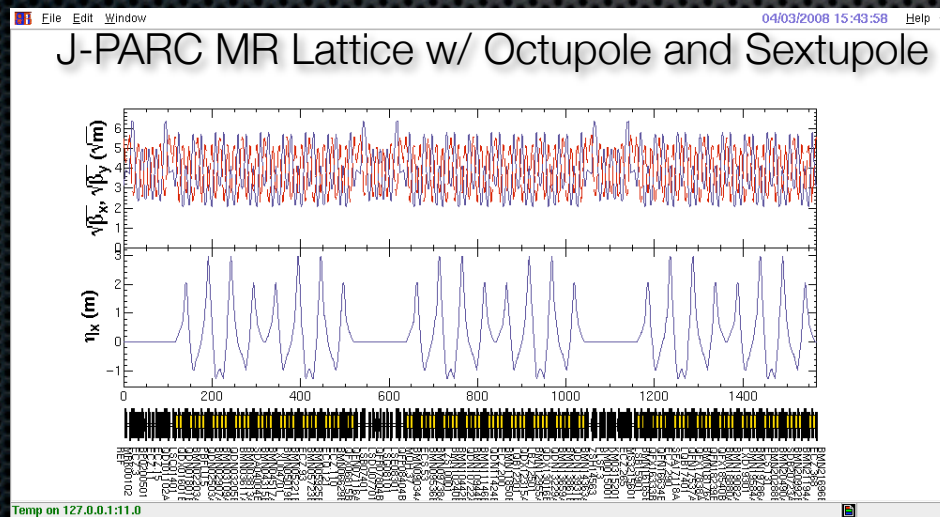
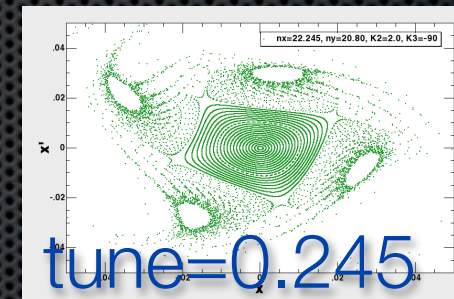
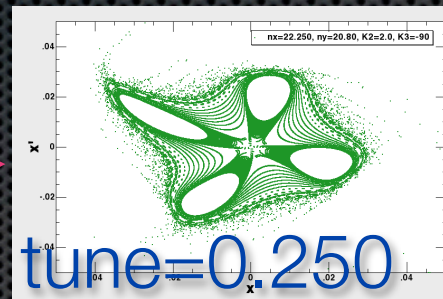
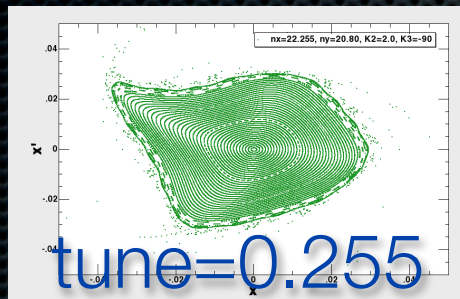
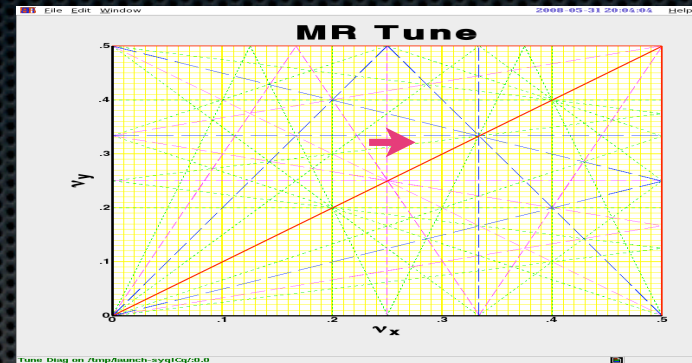
M. Giovannozzi and PS multi turn extraction (MTE) project group

- Multi turn extraction (MTE)
 - Splitting by transverse phase space
 - No loss by mechanical septum.
- Experimental test was successfully carried out at CERN
 - two sextupole and one octupole



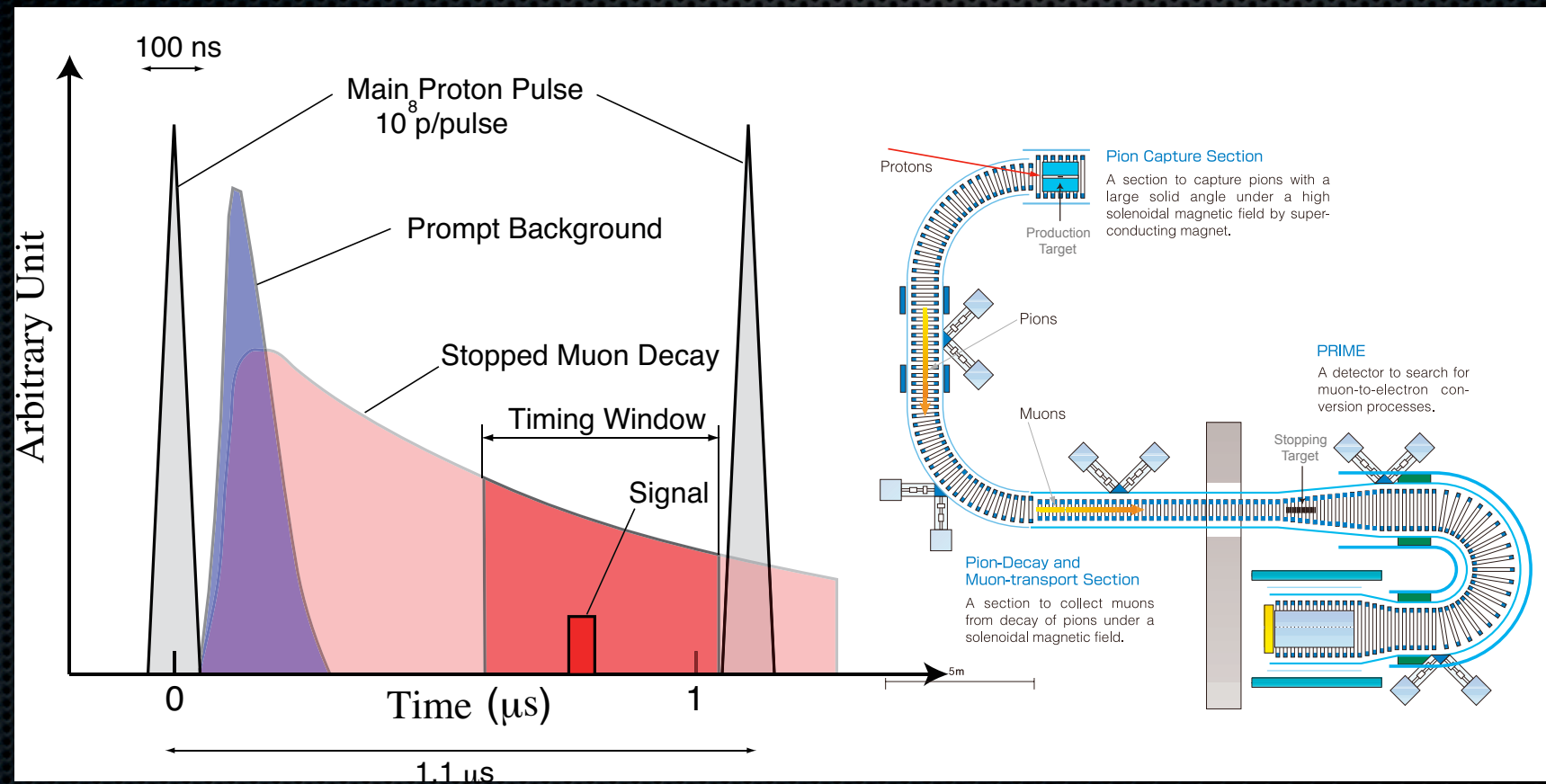
Study for J-PARC

Tawada, Sakumi, Saito et al.



Budget is being requested for the test experiment at J-PARC

Why Extinction is necessary for COMET?



Goal for Extinction study?

- Extinction Goal $\sim 10^{-9}$
 - How to measure by overcoming huge dynamic range?
 - Integrated by time to reduce detector rate
 - good S/N in measurement is essential
 - Avoid prompt pulse
 - Fast switching device (gated PMT, light shutter, kicker magnet)
 - How to improve?
 - While circulating in the ring
 - Clean up all remaining particle except for main pulses.
 - Coherent betatron motion (BNL study)
 - After extraction (One pass)
 - Kick out unwanted particles between pulse

Measurement using slow-extacted beam

- Realistic measurement similar to real exp.

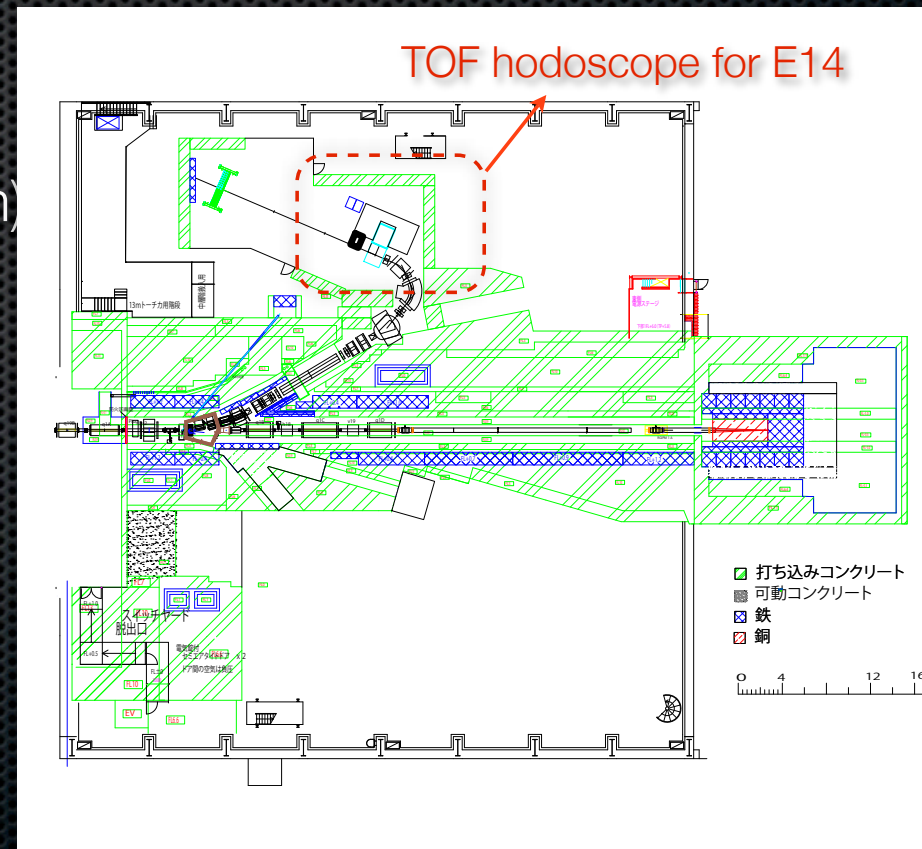
- including effect of extraction, beam manipulation
- No clue to source of extinction

- K1.8 BR beamline (2ndary beam)

- Max momentum 1.2 GeV/c
- DC separator is available
- Using TOF setup for E14 exp.

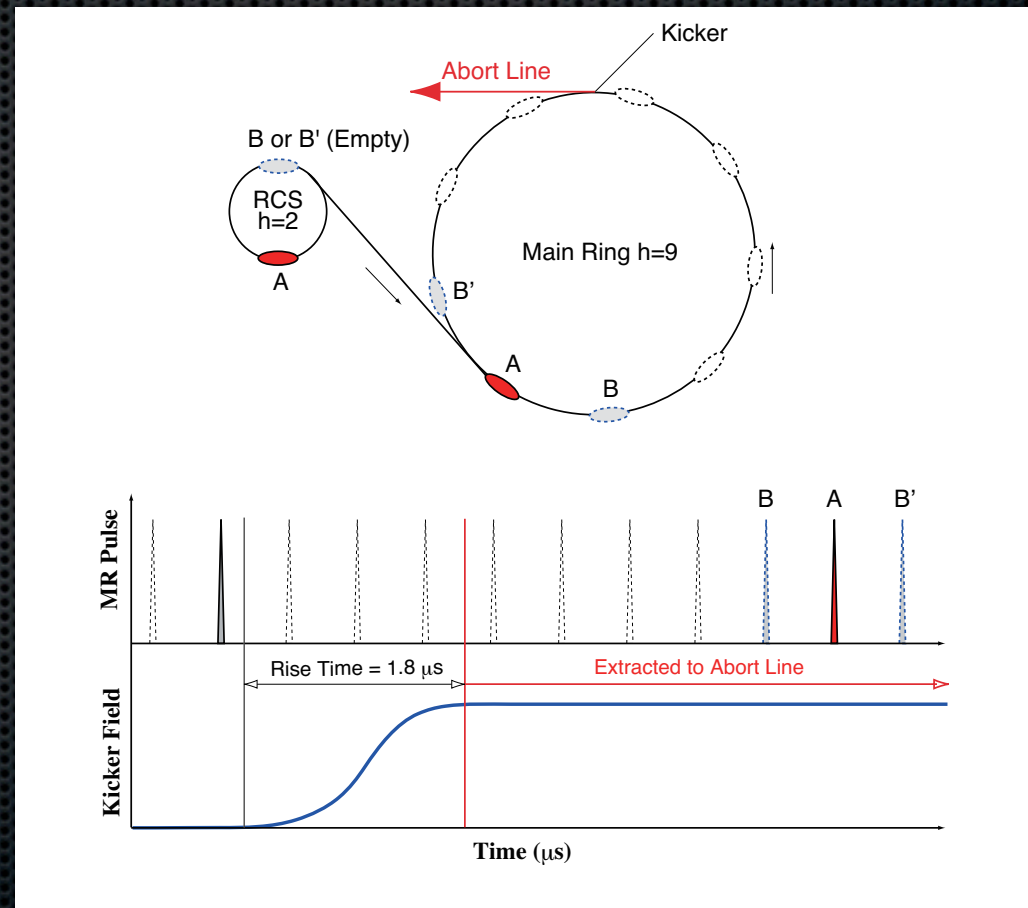
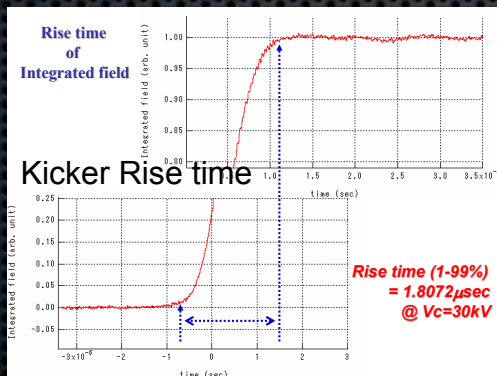
- Measurement

- PID to reject late arriving particles
- 50 K pion/pulse
- One day data taking

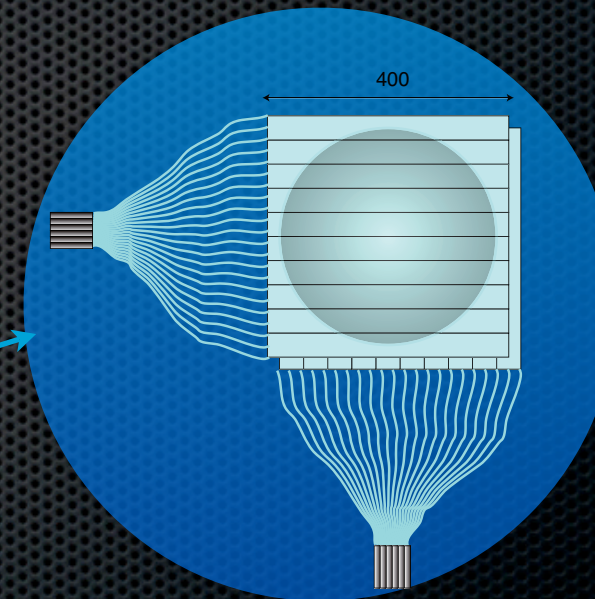
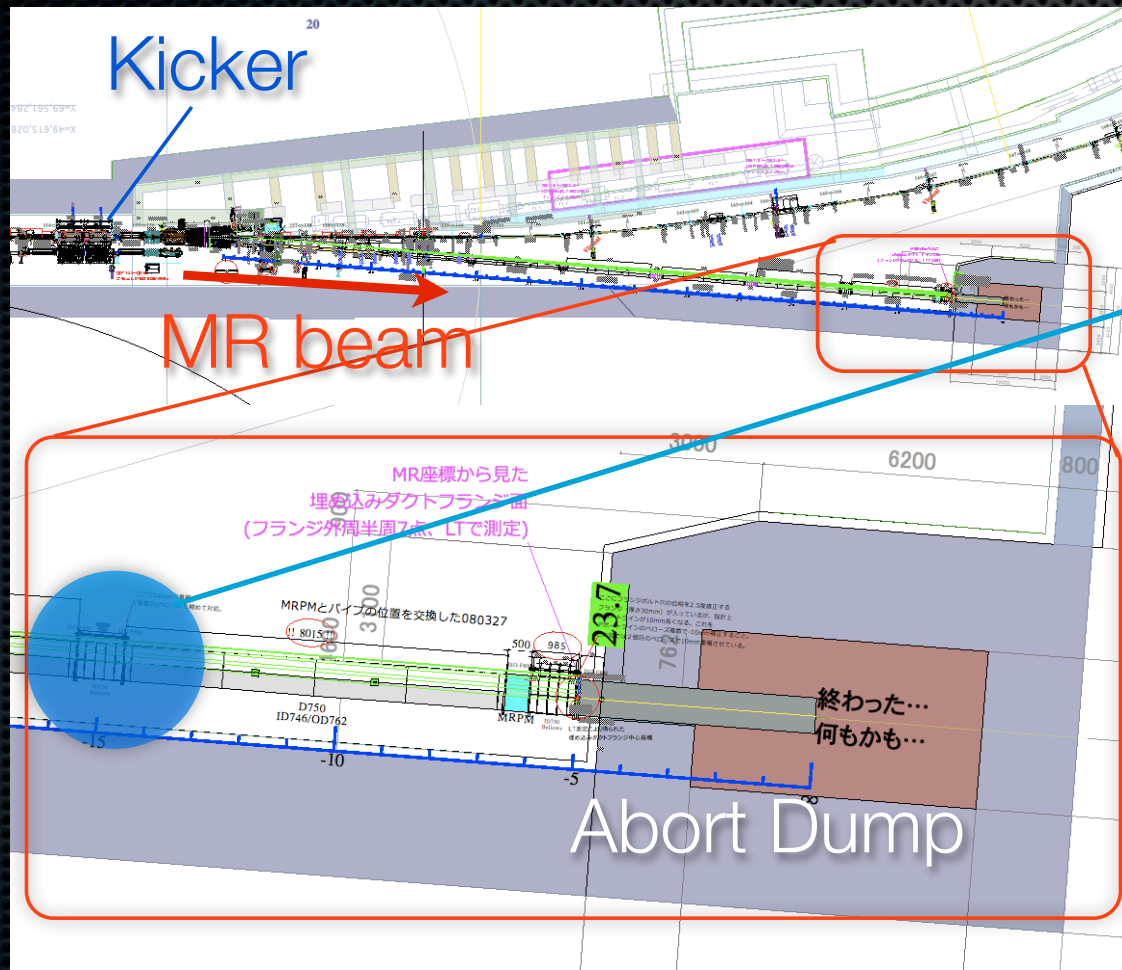


Measurement using fast extracted beam

By changing order of injecting pulse, i.e. (B) Empty bucket before main pulse or (B') empty bucket after main pulse, we can measure the particle number contained in empty RCS bucket.



Experimental setup



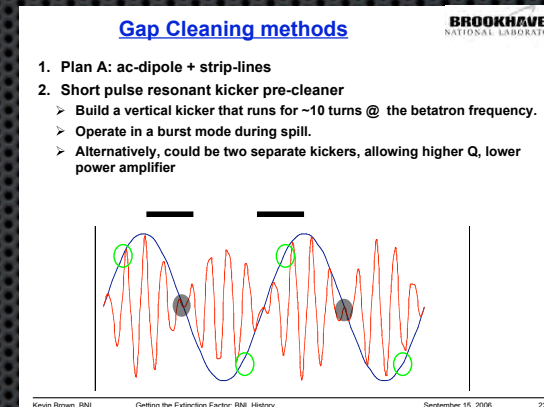
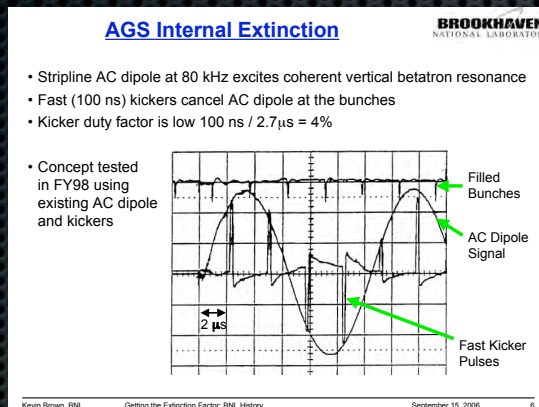
scintillator hodoscope
read thru fiber waveguide

Schedule

Date	Accelerator status	Test Experiment
Jul 2008 ~Nov 2008	Shutdown for installation	Installation detector into abort area
Dec 2008 ~Jan 2009	Acceleration test	Measurement at Abort dump
Feb 2009 ~Mar 2009	Slow extraction	Measurement at NH hall

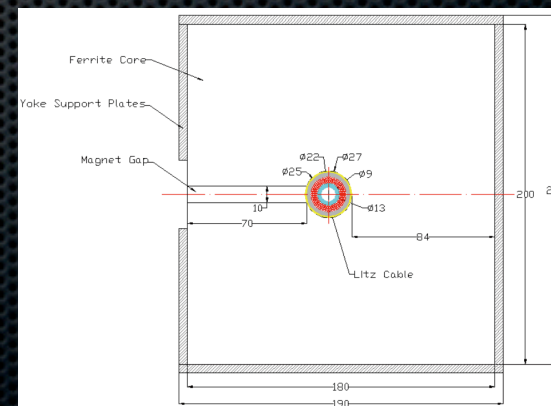
R&D for improvement of Extinction

- ✦ BNL study for MECO
Internal extinction w/ AC dipole and kicker



- ✦ FNAL design study for US-JAPAN

Gap cleaning after extraction
Conceptual design of AC dipole was done.



Summary

- ✦ We have started R&D work on accelerator beam for the future muon projects.
- ✦ Test experiment will be performed in the end of this year.
- ✦ Collaboration work for accelerator R&D has started.
 - ✦ BNL: Multi turn extraction, Extinction study
 - ✦ FNAL: Extinction study
 - ✦ CERN: Multi turn extraction